

Claims

[c1] What is claimed is:

An apparatus for relating the position of an electron beam traveling in a vacuum chamber along a beam axis to a mechanical reference, the apparatus comprising:

an outer support member adapted for motion along a first transverse axis and flexibly mounted to a reference frame;

an inner support member adapted for motion along a second transverse axis and flexibly mounted within said outer support member; and

a beam-detecting unit in a reference plate supported by said inner support member, said reference plate comprising a central aperture permitting the passage of the electron beam, a scattering unit for scattering electrons from said electron beam, a detector for detecting electrons scattered from said electron beam by said scattering unit and a set of reference mirrors oriented along said first and second transverse axes, whereby signals from said detector representing the position of said beam relative to said detector may be associated with measurements of the position of said reference mirrors.

[c2] An apparatus according to claim 1, in which said detector for detecting scattered electrons includes means for detecting the location of the beam in a transverse plane perpendicular to the beam axis.

- [c3] An apparatus according to claim 1, further comprising means for detecting the position of the reference plate relative to the beam axis.
- [c4] An apparatus according to claim 1, in which the outer support member is supported in a reference frame by a set of flexures that are compliant along said first transverse axis and stiff along said second transverse axis and along said beam axis.
- [c5] An apparatus according to claim 4, in which the inner support member supporting said reference plate is supported by a set of flexures that are compliant along said second transverse axis and stiff along said first transverse axis and along said beam axis.
- [c6] An apparatus according to claim 5, in which at least the inner support member is clamped during operation and unclamped during adjustment by clamps that are actuated by actuators extending through the chamber wall into the vacuum chamber.
- [c7] An apparatus for changing the position of a reference member in a vacuum chamber, the apparatus comprising:
 - an outer support member adapted for motion along a first transverse axis and flexibly mounted to a reference frame;
 - an inner support member adapted for motion along a second transverse axis and flexibly mounted within said outer support member;

a reference member supported by said inner support member; first translation means extending through a wall of said vacuum chamber and adapted to drive said outer support member along said first transverse axis; and second translation means extending through a wall of said vacuum chamber and adapted to drive said inner support member along said second transverse axis.

- [c8] An apparatus according to claim 7, further comprising means for detecting the position of the reference plate relative to a system axis.
- [c9] An apparatus according to claim 7, in which the outer support member is supported in a reference frame by a set of flexures that are compliant along said first transverse axis and stiff along said second transverse axis and along said beam axis.
- [c10] An apparatus according to claim 9, in which the inner support member supporting said reference plate is supported by a set of flexures that are compliant along said second transverse axis and stiff along said first transverse axis and along said beam axis.
- [c11] An apparatus according to claim 7, in which at least the inner support member is clamped during operation and unclamped during adjustment by clamps that are actuated by actuators extending into the vacuum chamber.

- [c12] An apparatus according to claim 8, in which at least the inner support member is clamped during operation and unclamped during adjustment by clamps that are actuated by actuators extending into the vacuum chamber.
- [c13] An apparatus according to claim 9, in which at least the inner support member is clamped during operation and unclamped during adjustment by clamps that are actuated by actuators extending into the vacuum chamber.
- [c14] An apparatus according to claim 10, in which at least the inner support member is clamped during operation and unclamped during adjustment by clamps that are actuated by actuators extending into the vacuum chamber.
- [c15] An apparatus for changing the position of a reference member in a vacuum chamber, the apparatus comprising:
 - at least one support member adapted for motion along a first transverse axis;
 - a reference member supported by said at least one support member;
 - first translation means extending through a wall of said vacuum chamber and adapted to drive said at least one support member along said first transverse axis; and
 - at least one clamping mechanism for clamping said reference member to a support member, said clamping mechanism being actuated by a clamping actuator extending through said

wall of said vacuum chamber that applies large clamping force in a normal vector with transverse force component below a threshold value.

- [c16] An apparatus according to claim 15, in which said at least one clamping mechanism clamps said at least one support member to a stationary member.
- [c17] An apparatus according to claim 15, in which said at least one support member comprises a first support member adapted for motion along said first transverse axis and a second support member adapted for motion along a second transverse axis, said first support member being driven by said first translation means extending through a wall of said vacuum chamber and said second support member being driven by second translation means extending through a wall of said vacuum chamber.
- [c18] An apparatus according to claim 17, in which said at least one clamping mechanism clamps said reference member to said second support member.
- [c19] An apparatus according to claim 17, in which said first support member is supported in a reference frame by a set of flexures that are compliant along said first transverse axis and stiff along said second transverse axis and along said beam axis; said second support member is disposed within said first

support member and flexibly mounted within said outer support member by a set of flexures that are compliant along said second transverse axis and stiff along said first transverse axis and said second translation means is adapted to drive said inner support member along said second transverse axis independently of said first support member.

[c20] An apparatus according to claim 17, in which said at least one clamping mechanism clamps said at least one support member to a stationary member.